

WHAT IS CLAIMED IS:

1. A flow rate sensor comprising:
 - a sensor pipe arranged in parallel to a bypass of a fluid passage;
 - a resistor group spirally wound around the sensor pipe and consisting of an even number of resistors having a resistance value changing according to the temperature and connected in series in the longitudinal direction of the sensor pipe;
 - a reference resistor group consisting of a plurality of reference resistors connected in series to one another and connected in parallel to the aforementioned resistor group;
 - a constant current source for flowing a constant current to the resistor group and the reference resistor group;
 - a first differential circuit for detecting a potential difference between a connection point between the reference resistors and a connection point between the resistors; and
 - a flow rate decision unit for deciding a flow rate of a fluid flowing in the fluid passage according to the potential difference output from the first differential circuit;
- the flow rate sensor further comprising:
 - at least one bypass circuit having switch means for selectively shortcircuiting a part of the even number of resistors so as to perform bypassing;

at least one flow rate range increasing differential circuit for detecting a potential difference between the bypass circuit and the connection point between the reference resistors; and

a second flow rate decision unit for detecting the flow rate of the fluid flowing in the fluid passage according to the potential difference output from the flow rate range increasing differential circuit.

2. A flow rate sensor as claimed in Claim 1, wherein there are provided four of the resistors and two of the reference resistors, and the bypass circuit bypasses the two resistors connected in series at the center.

3. A flow rate sensor comprising:

a sensor pipe arranged to bypass a bypass of a fluid passage;

a resistor group consisting of an even number of resistors having a resistance value changing according to the temperature, connected in series in the longitudinal direction of the sensor pipe, and mounted on the sensor pipe;

a reference resistor group consisting of a plurality of reference resistors connected in series to one another and connected in parallel to the aforementioned resistor group;

a constant current source for flowing a constant current to the resistor group and the

reference resistor group;

a first differential circuit for detecting a potential difference between a connection point between the reference resistors and a connection point between the resistors; and

a flow rate decision unit for deciding a flow rate of a fluid flowing in the fluid passage according to the potential difference output from the first differential circuit;

the flow rate sensor further comprising flow rate range increasing measurement means for increasing the flow rate range,

the flow rate range increasing measurement means having:

a dummy sensor pipe where no fluid is flown;

a dummy resistor group consisting of one or more dummy resistors having a resistance value changing according to the temperature and mounted in the longitudinal direction of the dummy sensor;

a dummy reference resistor group connected between the downstream side of the dummy resistor group and the upstream side of the resistor group and consisting of a plurality of dummy reference resistors connected in series;

a for-dummy constant current source connected to the both ends of the dummy reference resistor group for flowing a constant current;

switch means for selectively connecting in

series the resistor group and the dummy resistor group;

a flow rate range increasing differential circuit for detecting a potential difference between the input side of the dummy resistor group and the connection point between the dummy reference resistors; and

a third flow rate decision unit for detecting the flow rate of the fluid flowing in the fluid passage according to the potential difference output from the flow rate range increasing differential circuit.

4. A flow rate sensor as claimed in claim 1, the sensor further comprising:

a dummy sensor pipe where no fluid is flown;

a dummy resistor group consisting of one or more dummy resistors having a resistance value changing according to the temperature and mounted in the longitudinal direction of the dummy sensor;

a dummy reference resistor group connected between the downstream side of the dummy resistor group and the upstream side of the resistor group and consisting of a plurality of dummy reference resistors connected in series;

a for-dummy constant current source connected to the both ends of the dummy reference resistor group for flowing a constant current;

switch means for selectively connecting in series the resistor group and the dummy resistor group;

a flow rate range increasing differential

circuit for detecting a potential difference between the input side of the dummy resistor group and the connection point between the dummy reference resistors; and

a third flow rate decision unit for detecting the flow rate of the fluid flowing in the fluid passage according to the potential difference output from the flow rate range increasing differential circuit.

5. A flow rate sensor as claimed in claim 4, the sensor further comprising:

a first switch for selecting a connection point between the resistors and

a second switch for selecting a connection point between the dummy reference resistors.

6. A flow rate sensor comprising:

a sensor pipe connected in parallel to a bypass of a fluid passage;

a main resistor wound on the sensor pipe and changing its resistance value according to the temperature and heat value according to the current;

a constant current source for flowing a constant current to the main resistor;

reference value detection means capable of obtaining a reference value according to the ambient temperature; and

first flow rate detection means for detecting the flow rate of the fluid flowing in the fluid passage according to the voltage applied to both ends of the

main resistor and the reference value obtained by the reference value detection means.

7. A flow rate sensor as claimed in claim 6, wherein the reference value detection means comprises:
 a dummy sensor pipe where no fluid is flown;
 a for-dummy resistor wound on the dummy sensor pipe and changing its resistance value according to the temperature and its heat value according to the current flowing;
 a for-dummy constant current source for flowing a constant current to the for-dummy resistor; and
 a for-dummy voltage detection unit for detecting voltage at both ends of the for-dummy resistor so as to serve as the reference value.

8. A flow rate sensor as claimed in claim 6, wherein the reference value detection means has a coefficient matching unit for matching the resistance temperature coefficients of the main resistor and the for-dummy resistor.

9. A flow rate sensor as claimed in claim 6, wherein the reference value detection means has one of a thermistor, a thermocouple, and a temperature measuring resistor for detecting the ambient temperature as a voltage value.

10. A flow rate sensor as claimed in claim 9, wherein the reference value detection means has a coefficient matching unit for matching the ambient

temperature characteristic of the voltage value detected according to the ambient temperature with the ambient temperature characteristic of the voltage at both ends of the main resistor when no fluid is flown through the sensor pipe.

11. A flow rate sensor as claimed in claim 6, wherein the reference value detection means stores a voltage at both ends of the main resistor before starting flow of the fluid in the sensor pipe, so as to use the stored value as the reference value.

12. A flow rate sensor as claimed in claim 6, the sensor further comprising:

a middle terminal for extracting voltage at an arbitrary position of the main resistor;

second flow rate detection means for detecting the flow rate of the fluid flowing in the fluid passage by calculating the difference between the voltage of the upstream side of the main resistor as compared to the middle terminal and the voltage of the downstream side of the main resistor as compared to the middle terminal; and

switch means for switching between the output of the second flow rate detection means and the output of the first flow rate detection means.

13. A flow rate sensor as claimed in claim 12, the sensor further comprising:

an upstream side terminal arranged at an arbitrary point between the upstream side end of the

main resistor and the middle terminal;

a downstream side terminal arranged at an arbitrary position between the downstream side end of the main resistor and the middle terminal;

third flow rate detection means for detecting the flow rate of the fluid flowing in the fluid passage by calculating the difference between the voltage between the upstream side end and the upstream side terminal and the voltage between the downstream side end and the downstream side terminal; and

switch means for selectively switching between the outputs of the first, the second, and the third flow rate detection means.

14. A flow rate sensor as claimed in claim 12, wherein each of the flow rate detection means has a flow rate calculation unit for adjusting a gain.

15. A flow rate sensor comprising:

a sensor pipe arranged in parallel to a bypass of a fluid passage;

a main resistor wound on the sensor pipe and changing its resistance value according to the temperature and its heat value according to the current;

a constant current source for flowing a constant current to the main resistor;

a middle terminal for extracting voltage at an arbitrary position of the main resistor;

second flow rate detection means for

obtaining the flow rate of the fluid flowing in the fluid passage by calculating the difference between the voltage of the upstream side of the main resistor as compared to the middle terminal and the voltage of the downstream side of the main resistor as compared to the middle terminal;

an upstream side terminal arranged at an arbitrary point between the upstream side end of the main resistor and the middle terminal;

a downstream side terminal arranged at an arbitrary point between the downstream side end of the main resistor and the middle terminal;

third flow rate detection means for obtaining the flow rate of the fluid flowing in the fluid passage by calculating the difference between the voltage between the upstream side end and the upstream side terminal and the voltage between the downstream side end and the downstream side terminal; and

switch means for selectively switching between the outputs of the second and the third flow rate detection means.

16. A flow rate sensor comprising:

a sensor pipe arranged in parallel to a bypass of a fluid passage;

a main resistor wound on the sensor pipe and changing its resistance value according to the temperature and its heat value according to the current;

a constant temperature control circuit for maintaining the temperature of the main resistor and the difference between the temperature and the ambient temperature to be constant;

a middle terminal for extracting voltage at an arbitrary position of the main resistor;

fourth flow rate detection means for obtaining the flow rate of the fluid flowing in the fluid passage by calculating the difference between the upstream side power applied to the upstream side of the main resistor as compared to the middle terminal and the downstream side power applied to the downstream side of the main resistor as compared to the middle terminal;

reference value detection means capable of detecting a reference value according to the ambient temperature;

fifth flow rate detection means for obtaining the flow rate of the fluid flowing in the fluid passage according to all the power applied to the main resistor and the reference value obtained by the reference value detection means; and

switch means for selectively switching between the outputs of the fourth and the fifth flow rate detection means.

17. A flow rate sensor as claimed in claim 16, wherein the reference value detection means comprises:

a dummy sensor pipe where no fluid is flown;

a for-dummy resistor wound on the dummy sensor pipe and changing its resistance value according to the temperature and its heat value according to the current flowing;

a for-dummy constant temperature control circuit for maintaining the temperature of the for-dummy resistor or the difference between the temperature and the ambient temperature to be constant;

a for-dummy power detection unit for detecting power applied to the for-dummy resistor so as to serve as the reference value.

18. A flow rate sensor as claimed in claim 16, wherein the reference value detection means stores all the power applied to the main resistor before start of flowing of the fluid in the sensor pipe and uses the stored value as the reference value.

19. A flow rate sensor as claimed in claim 16, wherein each of the fourth and the fifth flow rate detection means has a flow rate calculation unit for adjusting the gain.

20. A flow rate sensor as claimed in claim 14, wherein the flow rate calculation units have different gains so that the flow rate control characteristic has a discontinuity point or a flexion point according to switching of the switch means.

21. A flow rate sensor as claimed in claim 19, wherein the flow rate calculation units have different gains so that the flow rate control characteristic has

a discontinuity point or a flexion point according to switching of the switch means.

22. A flow rate sensor as claimed in claim 14, wherein the flow rate calculation unit has a gain exhibiting LOG characteristic.

23. A flow rate sensor as claimed in claim 19, wherein the flow rate calculation unit has a gain exhibiting LOG characteristic.

24. A flow rate measuring device comprising a flow rate sensor disclosed in claim 1 and a display unit displaying a flow rate obtained by the flow rate sensor.

25. A flow rate measuring device comprising a flow rate sensor disclosed in claim 3 and a display unit displaying a flow rate obtained by the flow rate sensor.

26. A flow rate measuring device comprising a flow rate sensor disclosed in claim 6 and a display unit displaying a flow rate obtained by the flow rate sensor.

27. A flow rate measuring device comprising a flow rate sensor disclosed in claim 15 and a display unit displaying a flow rate obtained by the flow rate sensor.

28. A flow rate measuring device comprising a flow rate sensor disclosed in claim 16 and a display unit displaying a flow rate obtained by the flow rate sensor.

29. A flow rate control device comprising:
a flow rate sensor disclosed in claim 1;
a flow rate control valve provided in a fluid passage; and

an actuator controlling valve opening degree of the flow rate control valve according to an output value of the flow rate sensor.

30. A flow rate control device comprising:
a flow rate sensor disclosed in claim 3;
a flow rate control valve provided in a fluid passage; and

an actuator controlling valve opening degree of the flow rate control valve according to an output value of the flow rate sensor.

31. A flow rate control device comprising:
a flow rate sensor disclosed in claim 6;
a flow rate control valve provided in a fluid passage; and

an actuator controlling valve opening degree of the flow rate control valve according to an output value of the flow rate sensor.

32. A flow rate control device comprising:
a flow rate sensor disclosed in claim 15;
a flow rate control valve provided in a fluid passage; and

an actuator controlling valve opening degree of the flow rate control valve according to an output value of the flow rate sensor.

33. . A flow rate control device comprising:
- a flow rate sensor disclosed in claim 16;
 - a flow rate control valve provided in a fluid passage; and
 - an actuator controlling valve opening degree of the flow rate control valve according to an output value of the flow rate sensor.